NASA Facts

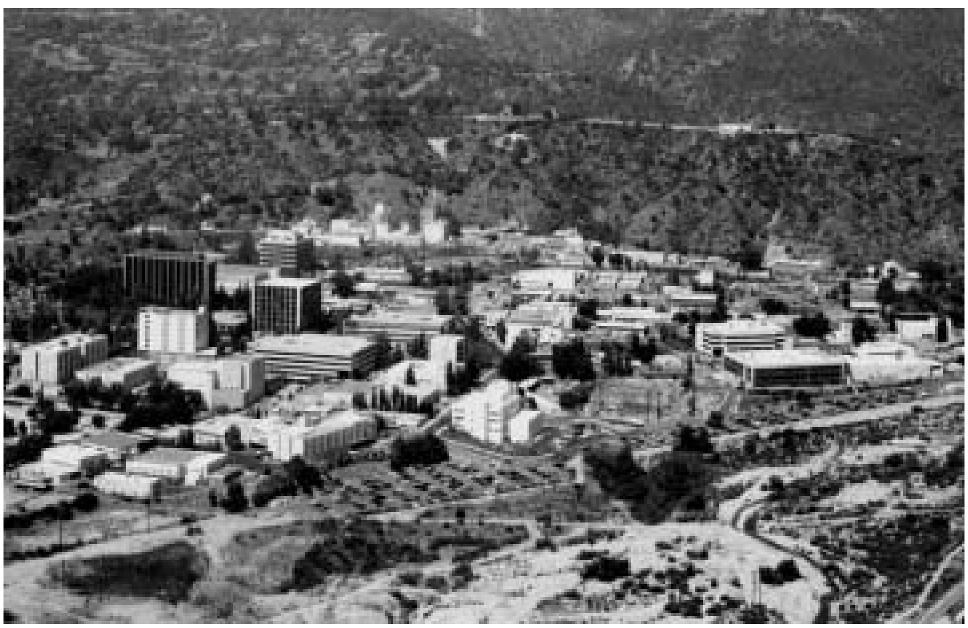
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

Jet Propulsion Laboratory

A new generation of space missions to explore the solar system and the universe beyond is unfolding at the Jet Propulsion Laboratory.

The American space age began January 31, 1958, with the launch of the first U.S. satellite, Explorer 1, built and controlled by JPL. In the four decades since then, JPL has led the world in exploring all of the solar system's known planets, except Pluto, with robotic spacecraft. The tools developed at JPL for its spacecraft expeditions to other planets have also proved invaluable in providing new insights and discoveries in studies of Earth, its atmosphere, climate, oceans, geology and the biosphere.



Entering the new millennium as the 21st century begins, JPL continues as a world leader in science and technology, breaking new ground in the miniaturization and efficiency of spacecraft components. At the same time, the Laboratory is pushing the sensitivity of space sensors and broadening their applications for a myriad of scientific, medical, industrial and commercial uses on Earth.

JPL is a federally funded research and development facility managed by the California Institute of Technology for the National Aeronautics and Space Administration.

JPL's Beginnings

JPL's history dates to the 1930s, when Caltech professor Theodore von Kármán conducted pioneering work in rocket propulsion. Von Kármán, head of Caltech's Guggenheim Aeronautical Laboratory, gathered with several graduate students to test a primitive rocket engine in a dry riverbed wilderness area in the Arroyo Seco, a dry canyon wash north of the Rose Bowl in Pasadena, California. Their first rocket firing took place there on October 31, 1936.

After the Caltech group's successful rocket experiments, von Kármán, who also served as a scientific adviser to the U.S. Army Air Corps, persuaded the Army to fund development of strap-on rockets (called "jet-assisted take-off") to help overloaded Army airplanes to take off from short runways. The Army helped Caltech acquire land in the Arroyo Seco for test pits and temporary workshops. Airplane tests at nearby air bases proved the concept and tested the designs. by this time, World War II had begun and the rockets were in demand.

As the group wound up the work on the jet-assisted takeoff rockets, the Army Air Corps asked von Kármán for a technical analysis of the German V-2 program just discovered by Allied intelligence. He and his research team then proposed a U.S. research project to understand, duplicate and reach beyond the guided missiles beginning to bombard England. In the proposal, the Caltech team referred to their organization for the first time as "the Jet Propulsion Laboratory."

Funded by Army Ordnance, the Jet Propulsion Laboratory's early efforts would eventually involve technologies beyond those of aerodynamics and propellant chemistry, technologies that would evolve into tools for space flight, secure communications, spacecraft navigation and control, and planetary exploration.

The team of about 100 rocket engineers began to expand, and the team began testing in the California desert of small unguided missiles (named Private) that reached a range of nearly 18 kilometers (about 11 miles). They experimented with radio telemetry from missiles, and began planning for ground radar and radio sets. By 1945, with a staff approaching 300, the group had begun to launch test vehicles from White Sands, New Mexico, to an altitude of 60 kilometers (200,000 feet), monitoring performance by radio.

Control of the guided missile was the next step, requiring two-way radio as well as radar and a primitive computer (using radio tubes) at the ground station. The result was JPL's answer to the German V-2 missile, named Corporal, first launched in May 1947, about two years after the end of war with Germany.

Developing a missile that would fly and survive in the field involved testing its aerodynamic design and durability under vibration and other stresses. The team developed a supersonic wind tunnel and an array of environmental test technologies, all of which had wider use and came to support outside customers. Developing so complex a device as a missile to fly unaided and beyond reach of repair meant a new degree of quality, new test techniques and a new discipline called system engineering.

Subsequent Army work further sharpened the technologies of communications and control, of design and test and performance analysis. This made it possible for JPL to develop the flight and ground systems and finally to fly the first successful U.S. space mission, Explorer 1. The entire three-month effort began in November 1957 and culminated with the successful launch on January 31, 1958.

On December 3, 1958, two months after NASA was created by Congress, JPL was transferred from Army jurisdiction to that of the new civilian space agency. It brought to the new agency experience in building and flying spacecraft, an extensive background in solid and liquid rocket propulsion systems, guidance, control, systems integration, broad testing capability, and expertise in telecommunications using low-power spacecraft transmitters and very sensitive Earth-based antennas and receivers.

The Laboratory now covers some 72 hectares (177 acres) adjacent to the site of von Kármán's early rocket experiments. Jet propulsion is no longer the focus of JPL's work, but the world-renowned name remains the same.

Planetary Exploration

In the 1960s, JPL began to conceive and execute robotic spacecraft to explore other worlds. This effort began with the Ranger and Surveyor missions to the Moon, paving the way for NASA's Apollo astronaut lunar landings. During that same period and through the early 1970s, JPL carried out Mariner missions to Mercury, Venus and Mars.

Mariner 2 became the first spacecraft to fly by another planet following its launch August 27, 1962, to Venus (Mariner 1 was lost because of a launch vehicle error). Other successful Mariners included Mariner 4, launched in 1964 to Mars; Mariner 5, launched in 1967 to Venus; Mariner 6, launched in 1969 to Mars; Mariner 7, launched in 1969 to Mars; and Mariner 9, launched in 1971 to orbit Mars.

Mariner 10 became the first spacecraft to use a "gravity-assist" boost from one planet to send it on to another — a key innovation in spaceflight that would later enable the exploration of outer planets that would have otherwise been unreachable. Mariner 10's launch in November 1973 delivered the spacecraft to Venus in February 1974, where a gravity-assist swingby allowed it to fly by Mercury in March and September that year.

The first search for life on Mars was conducted in 1975 when NASA launched the Viking mission's two orbiter spacecraft and two Martian landers. The elaborate mission was divided between several NASA centers and private U.S. aerospace firms, with JPL building the Viking orbiters, conducting mission communications and eventually assuming responsibility for management of the mission.

Credit for the single mission that has visited the most planets goes to JPL's Voyager project. Launched in 1977, the twin Voyager 1 and Voyager 2 spacecraft flew by the planets Jupiter (1979) and Saturn (1980-81). Voyager 2 then went on to an encounter with the planet Uranus in 1986 and a flyby of Neptune in 1989. Early in 1990, Voyager 1 turned its camera around to capture a series of images assembled into a "family portrait" of the solar system. Still communicating their findings as they speed out toward interstellar space, the Voyagers are expected to communicate information about the Sun's energy field until perhaps the second decade of the 21st century. In February 1998, Voyager 1 passed NASA's Pioneer 10 to become the most distant human-made object in space.

In 1989 and 1990 NASA's Space Shuttle helped launch three JPL-managed solar system exploration missions: Magellan to Venus, Galileo to Jupiter and Ulysses to study the Sun's poles.

Magellan used a sophisticated imaging radar to pierce the cloud cover enshrouding Venus and map the planet's surface. Magellan was carried into Earth orbit in May 1989 by Space Shuttle Atlantis. Released from the Shuttle's cargo bay, Magellan was propelled by a booster engine toward Venus, where it arrived in August 1990. It completed its third 243-day period mapping the planet in September 1992. Magellan mapped variations in Venus's gravity field before the mission ended in October 1994. At the conclusion of the mission, flight controllers commanded Magellan to dip into the atmosphere of Venus in a test of aerobraking — a technique for using atmospheric drag to slow spacecraft that has since been used in other planetary missions.

The Galileo mission began October 18, 1989, when it was carried into Earth orbit on Space Shuttle Atlantis and then sent on its interplanetary flight path via an Inertial Upper Stage booster. Relying on gravity-assist swingbys to reach Jupiter, Galileo flew past Venus once and Earth twice. Along the way Galileo flew by the asteroid Gaspra in October 1991 and the asteroid Ida on August 28, 1993. On its final approach to the giant planet, Galileo observed Jupiter being bombarded by fragments of the broken-up comet Shoemaker-Levy 9. On July 12, 1995, Galileo separated from its atmospheric probe and the two spacecraft flew in formation to their final destination.

On December 7, 1995, Galileo fired its main engine to enter Jupiter orbit and collected data radioed from the probe during its parachute descent into the planet's atmosphere. During its two-year prime mission, Galileo conducted 10 targeted flybys of Jupiter's major moons. In December 1997, the spacecraft began a first extended mission, which featured eight flybys of Jupiter's icy moon Europa and two of the volcanic moon Io. A second extended mission began in early 2000, including flybys of the moons Io and Ganymede, plus coordinated observations with the Cassini spacecraft as Cassini flew past Jupiter in December 2000 for a gravity assist to reach Saturn.

NASA's shuttle fleet again launched a probe bound for other parts of the solar system when the Space Shuttle Discovery carried aloft Ulysses in October 1990. A joint mission between NASA and the European Space Agency, this project for the first time sent a spacecraft out of the ecliptic — the plane in which Earth and other planets orbit the Sun — to study the Sun's north and south poles. Ulysses first flew by Jupiter in February 1992, where the giant planet's gravity flung it into an unusual solar orbit nearly perpendicular to the ecliptic plane. The prime mission concluded in September 1995. In April 1998, Ulysses began its second orbit of the Sun.

The mission of Mars Observer, launched aboard a Titan III rocket September 25, 1992, ended with disappointment in August 1993 when contact was lost with the spacecraft shortly before it was to enter orbit around Mars. Some science instruments from Mars Observer are currently being reflown on Mars Global Surveyor.

The next JPL planetary launches were those of Mars Global Surveyor and Mars Pathfinder, launched in November and December 1996, respectively. Mars Pathfinder put a lander and rover on the surface of the red planet in a highly successful landing July 4, 1997; the project fulfilled all the objectives of its prime mission and lasted considerably longer than originally designed before the lander fell silent in September 1997. Mars Global Surveyor went into orbit around the red planet on September 12, 1997 (September 11 EDT/PDT), and spent a year and a half lowering its orbit using the technique of aerobraking. The spacecraft began its prime mission in spring 1999 and is currently making highly detailed maps of the Martian surface.

A disappointment at Mars occurred in late 1999, however, with the loss of the orbiter and lander developed and launched under the Mars ’98 project — named Mars Climate Orbiter and Mars Polar Lander, respectively. Climate Orbiter entered the planet’s atmosphere too low and did not survive orbit insertion on September 23, 1999. Polar Lander and two Deep Space 2 microprobes piggybacking on it to Mars were lost during arrival at the planet December 3, 1999.

A orbiter named Mars Odyssey was launched on April 7, 2001, and arrived at the red planet on October 24 of that year (October 23 EST/PST). The spacecraft embarked on a four-year examination of what Mars is made of, detecting water and shallow buried ice, and studying the radiation environment in space.

The next Mars mission will be a pair of rovers due for launch in 2003. With far greater mobility than 1997’s Mars Pathfinder rover, these robotic explorers will be able to trek up to 100 meters (about 110 yards) across the surface each Martian day. Later proposed missions in the Mars program include a powerful reconnaissance orbiter in 2005, a “smart lander” and long-range rover in 2007, and small projects called “Scout” missions beginning in 2007, leading up to an eventual sample return mission.

JPL designed and built the Cassini mission to Saturn, launched on October 15, 1997. Cassini is carrying a probe, Huygens, provided by the European Space Agency, which will descend to the surface of Titan, Saturn’s largest moon, six months after Cassini's July 2004 arrival at the ringed planet. Titan appears to boast organic chemistry possibly like that which led to the existence of life on Earth. Cassini flew by Venus in April 1998 and June 1999, followed by an Earth flyby in August 1999 and a Jupiter flyby in December 2000.

In 1995, NASA selected a JPL-teamed proposal to develop and fly a mission called Stardust under the space agency’s Discovery program of low-cost missions. Launched in February 1999, Stardust will fly past comet Wild-2 in the year 2004 and collect dust and volatile materials. Those materials will be returned to Earth in a capsule that will parachute to a landing on a dry lake bed in Utah in 2006.

JPL is also providing project management for another Discovery mission, Genesis. Launched in August 2001, Genesis is collecting samples of charged particles in the solar wind and will return them to Earth laboratories in 2004 for detailed analysis. In addition, JPL is managing a Discovery mission called Deep Impact that will propel a large copper projectile into the surface of comet Tempel 1, creating a huge crater expected to reveal information about the composition and structure of the comet nucleus. Deep Impact is planned for launch in 2004 with comet arrival in mid-2005. A comet is also the destination for a JPL instrument called the Microwave Instrument on the Rosetta Orbiter, or Miro, which will be carried by a European Space Agency craft due for launch in 2003.

Another major initiative for a new breed of NASA spacecraft is New Millennium, designed to flight-test new technologies so that they can be reliably used in science missions of the 21st century.

The first New Millennium spacecraft, Deep Space 1, was launched in October 1998 to test an ion engine and 11 other new technologies. Deep Space 1 tested autonomous navigation and two advanced science instruments when it flew by the asteroid 9969 Braille on July 29, 1999 (July 28 PDT). After its primary mission, Deep Space 1 gathered images and other information from a bonus September 22, 2001, flyby of comet Borrelly. Under Deep Space 2, two microprobes to test the Martian soil for water vapor piggybacked on Mars Polar Lander, but were lost at arrival in December 1999. The New Millennium program also includes deep space and Earth orbiting missions managed by other NASA centers.

JPL is developing a mission to learn more about Jupiter's moon Europa, which data from Galileo suggest may harbor a vast liquid ocean under its frozen crust. The Europa Orbiter will be launched in 2008 or later.

In addition to directing spacecraft that visit planets, asteroids and comets, JPL scientists are active in many programs of observations from the ground. The Laboratory created the Near-Earth Asteroid Tracking system, an automated system used at an Air Force observatory in Hawaii to scan the skies for asteroids or comets that could threaten Earth. In 1999, the project made its first observations from a second site, the 1.2-meter-diameter (48-inch) Oschin telescope on Palomar Mountain, California. In 1998, NASA designated JPL as home of the agency's Near-Earth Objects Office to coordinate observations of Earth-crossing asteroids and comets by various NASA scientists.

Earth Sciences

In the late 1970s, JPL engineers and scientists realized that the sensors they were developing for interplanetary missions could be turned upon Earth itself to better understand our home planet. This has led to a series of highly successful Earth-orbiting missions that have evolved into a major segment of the Laboratory's activities, now sponsored by NASA's Office of Earth Sciences.

In 1978, JPL built an experimental satellite called Seasat to test a variety of oceanographic sensors including imaging radar, altimeters, radiometers and scatterometers. Many of the later Earth-orbiting instruments developed at JPL owe their legacy to the Seasat mission.

The imaging radar flown on Seasat led to a pair of missions flown on the Space Shuttle, 1981's Shuttle Imaging Radar-A and 1984's Shuttle Imaging Radar-B (SIR-B). These were followed by Spaceborne Imaging Radar-C, an experiment teamed with the German/Italian X-Band Synthetic Aperture Radar and flown on the Space Shuttle twice in 1994. This mission's goal was to study a variety of scientific disciplines — geology, hydrology, ecology and oceanography — by comparing the radar images to data collected by teams of people on the ground. Imaging radar was reflown on the Space Shuttle under the Shuttle Radar Topography Mission in February 2000.

Seasat also tested an altimeter that measured sea level heights from space. This concept led to a full-scale satellite mission developed jointly by JPL and the French space agency, Topex/Poseidon. The oceanographic satellite, launched August 10, 1992, on an Ariane 4 rocket from Kourou, French Guiana, has provided scientists with unprecedented insight into global climate and ocean interactions, currents, eddies, and new details about the global ocean seafloor. Jason 1, a follow-on mission to Topex/Poseidon and another U.S.-French collaboration, was launched December 7, 2001, and is currently in orbit.

Another mission with heritage in Seasat is the JPL-built NASA Scatterometer, an instrument that measures near-surface ocean winds from space. This instrument was launched in August 1996 on the Advanced Earth Observing Satellite prepared by Japan's National Space Development Agency, and continued operating until the satellite failed in early 1997. JPL prepared a rapid replacement, QuikScat, which was launched in June 1999 from Vandenberg Air Force Base, California. Also being readied is a next-generation scatterometer, Seawinds, to be launched by Japan in late 2001.

JPL also designed and built an instrument called the Microwave Limb Sounder that studies the chemistry of Earth's upper atmosphere, relaying important data on topics such as ozone depletion. Early versions flew as payloads on the Space Shuttle, followed by an instrument onboard NASA's Upper Atmosphere Research Satellite launched in September 1991. Currently, a new-generation version of the instrument is being developed to fly on a satellite for launch in 2003 under NASA's Earth Observing System program.

JPL is responsible for several other instruments being flown under the Earth Observing System program. They include the Multi-angle Imaging Spectro Radiometer, launched on NASA's Terra satellite in December 1999 to study the role of clouds in global climate; the Atmospheric Infrared Sounder, due for launch in 2002, which will relay data on temperature and humidity in the atmosphere, helping to understand how heat is exchanged between land, air, sea and the atmosphere; and the Tropospheric Emission Spectrometer, planned for launch in 2003, which will help scientists understand the causes of acid rain and track trends in atmospheric chemistry on a global scale.

The Active Cavity Radiometer Irradiance Monitor, or Acrim, is an instrument that measures the Sun's total output of optical energy from ultraviolet to infrared wavelengths -- called the total solar irradiance -- an important factor in the study of Earth's climate. The instrument was flown on several shuttle missions and satellites in the 1980s and 1990s. A dedicated satellite called AcrimSat was launched in December 1999.

Clouds will be the object of study for a trio of satellites called CloudSat planned for launch in 2003. They will be the first spacecraft to examine clouds on a global basis.

A JPL-teamed mission called the Gravity Recovery and Climate Experiment, or Grace, launched twin satellites on March 17, 2002, to conduct global high-resolution studies of Earth's gravity field.

JPL provided project management for the Solar Mesosphere Explorer, a satellite launched in 1981 to investigate the processes that create and destroy ozone in Earth's upper atmosphere.

Astrophysics

In addition to studying Earth itself and other bodies within the solar system, JPL has produced missions that have peered deeper into the universe.

JPL designed and built the Wide Field/Planetary Camera, the main observing instrument on NASA's Hubble Space Telescope. After a flaw was discovered in the space telescope's main mirror, JPL created a second-generation camera, the Wide Field and Planetary Camera 2, that compensated for the optical problem — essentially like fitting Hubble with a set of corrective eyeglasses. This second camera was installed by spacewalking astronauts during a shuttle mission in December 1993, allowing Hubble to fulfill its promise in producing unprecedented views of the cosmos.

JPL was U.S. manager of the Infrared Astronomical Satellite, a joint project of with the Netherlands and the United Kingdom. Launched in 1983, the mission was an Earth-orbiting telescope that mapped the sky in infrared wavelengths invisible to the eye. Its data have led to a wealth of discoveries about the formation of galaxies, stars and planets, including the first-ever direct evidence of an emerging planetary system around a star besides the Sun — material orbiting Vega, 26 light-years away. Previously unseen phenomena found by the telescope have led to gains in other areas of astronomy and astrophysics ranging from studies of comets to cosmology.

In 1996, NASA assigned JPL programmatic responsibility for the space agency's Origins program. The program ties together a variety of proposed instruments and spacecraft missions that will study the formation of galaxies, stars and planets, and search for Earth-like planets around nearby stars. The Space Interferometry Mission is being developed for launch in 2009 to search for planets around other stars. Among other missions under study is the Terrestrial Planet Finder, being considered for launch in 2012.

JPL is developing the Space Infrared Telescope Facility, an innovative orbiting infrared telescope that will build upon the success of the Infrared Astronomical Satellite, taking a deeper and more detailed look into the infrared sky to study galaxy formation and look for dark matter and discs of material around other stars. The new telescope is scheduled for launch in July 2002.

Starburst galaxies — vast clouds of molecular gas cradling the sites of newborn stars — were to be the target of the Wide-field Infrared Explorer, a small, cryogenically cooled infrared telescope launched on a Pegasus XL vehicle in 1999 as part of NASA's Small

Explorer program. The telescope's coolant was lost shortly after launch, effectively ending the mission; some science objectives will be picked up by the Space Infrared Telescope Facility mission when it launches in 2002. In October 1997, NASA selected another JPL-teamed mission for development under the Small Explorer program — the Galaxy Evolution Explorer, due for launch in April 2002.

To support the Origins program from the ground, JPL is involved in planning and designing a system that will link two telescopes at the Keck Observatory in Hawaii. The combined telescopes will function as an interferometer to detect large planets and dust clouds around nearby stars.

Telecommunications

To provide tracking and communications for planetary spacecraft, JPL designed, built and operates NASA's Deep Space Network of antenna stations. Communications complexes are located in California's Mojave Desert, in Spain and in Australia. In addition to NASA missions, the network regularly performs tracking for international missions sending spacecraft to deep space. Ground stations also conduct experiments using radar to image planets and asteroids, as well as experiments using the technique of very long baseline interferometry to study extremely distant celestial objects.

The Deep Space Network is also playing a major role in Space Very Long Baseline Interferometry, a radio astronomy project teaming orbiting spacecraft with ground antennas. Combining ground antennas with a Japanese spacecraft launched in 1997 approximately triples the resolving power previously achievable.

Technologies

In the three decades it has led the nation's planetary exploration program, JPL has honed several skills and areas of innovation, including deep space navigation and communication, digital image processing, imaging systems, intelligent automated systems, instrument technology, microelectronics and more. Many of these disciplines found applications outside the planetary spacecraft field, from solar energy to medical imagery.

In the mid-1970s, in response to a world energy crisis, JPL worked to develop and apply alternate sources of electricity such as solar energy, for the Department of Energy, and electric vehicles and other alternative transport systems, for the Department of Transportation.

The Laboratory has also applied space-based operational, communication, and information processing techniques to the needs of the Department of Defense, Federal Aviation Administration and other federal agencies. Its active technology transfer program with the industrial community dates back to the early days of the missile program.

JPL conducts technology development projects both for NASA and for sponsors other than NASA. Non-NASA projects at JPL have included Firefly, an aircraft-borne infrared fire mapping system for the U.S. Forest Service; a document monitoring system to help the National Archives safeguard the U.S. Constitution, Declaration of Independence and Bill of Rights; medical projects such as robot-assisted microsurgery and medical imaging systems, and Internet-based telemedical systems; and varied projects in such fields as advanced spacecraft and sensor technology, microelectronics, supercomputing and environmental protection.

JPL work for the Department of Defense has included the Miniature Seeker Technology Integration, a satellite built and launched in November 1992 to demonstrate miniature sensor technology and a rapid development system. JPL also managed the U.S. Army's All Source Analysis System project, a battlefield information management system.

Research and development activities at JPL include an active program of automation and robotics supporting planetary rover missions and NASA's Space Station program. In supercomputing, JPL has pioneered work with new types of massively parallel computers to support processing of enormous quantities of data to be returned by space missions in years to come.

Institutional

In addition to the Laboratory's main Pasadena site and the three DSN complexes around the world, JPL installations include an astronomical observatory at

Table Mountain, California, and a launch operations site at Cape Canaveral, Florida.

In 2002, JPL has a workforce of about 5,400 employees and on-site contractors, and an annual budget of approximately $1.4 billion.

Dr. Charles Elachi, a scientist with a background in imaging radar and other remote-sensing technologies, became director of JPL on May 1, 2001. In addition to his JPL post he serves as a vice president of Caltech. Elachi's predecessors as head of the Laboratory were Dr. Edward C. Stone (1991-2001), Dr. Lew Allen Jr. (1982-1990), Dr. Bruce Murray (1976-1982), Dr. William H. Pickering (1954-1976), Dr. Louis Dunn (1946-54), Dr. Frank Malina (1944-1946) and Dr. Theodore von Kármán (1944 and forerunner organization).

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JPL Spacecraft Missions

Spacecraft, Launch Date, Mission Description, Comment

Explorer 1, 1/31/58, first U.S. satellite, operated to 5/23/58

Explorer 2, 3/5/58, satellite, launch failed

Explorer 3, 3/26/58, satellite, operated to 6/16/58

Explorer 4, 7/26/58, satellite, operated to 10/6/58

Explorer 5, 8/24/58, satellite, launch failed

Pioneer 3, 12/6/58, escape attempt, in orbit to 12/7/58

Pioneer 4, 3/3/59, escaped to solar orbit, tracked to 650,000 km (400,000 mi)

Ranger 1, 8/23/61, lunar prototype, launch failure

Ranger 2, 11/18/61, lunar prototype, launch failure

Ranger 3, 1/26/62, lunar probe, spacecraft failed, missed Moon

Ranger 4, 4/23/62, lunar probe, spacecraft failed, impact

Ranger 5, 10/18/62, lunar probe, spacecraft failed, missed

Ranger 6, 1/30/64, lunar probe, impact, cameras failed

Ranger 7, 7/28/64, lunar probe, successful, 4,308 pictures

Ranger 8, 2/17/65, lunar probe, successful, 7,317 pictures

Ranger 9, 3/21/65, lunar probe, successful, 5,814 pictures

Surveyor 1, 5/30/66, lunar lander, operated 6/2/66-1/7/67

Surveyor 2, 9/20/66, lunar lander, crashed 9/23

Surveyor 3, 4/17/67, lunar lander, operated 4/20-5/4/67

Surveyor 4, 7/14/67, lunar lander, crashed 7/17

Surveyor 5, 9/8/67, lunar lander, operated 9/11-12/17/67

Surveyor 6, 11/7/67, lunar lander, operated 11/10-12/14/67

Surveyor 7, 1/7/68, lunar lander, operated 1/10-2/21/68

Mariner 1, 7/22/62, Venus probe, launch failed

Mariner 2, 8/27/62, Venus flyby 12/14/62, signal lost 1/3/63

Mariner 3, 11/5/64, Mars probe, shroud failed

Mariner 4, 11/28/64, Mars flyby 7/14/65 with pictures, signal lost 12/20/67

Mariner 5, 6/14/67, Venus flyby 10/19/67

Mariner 6, 2/24/69, Mars flyby 7/31/69 with pictures, lasted to 12/70

Mariner 7, 3/27/69, Mars flyby 8/5/69 with pictures, lasted to 12/70

Mariner 8, 5/8/71, failed Mars launch

Mariner 9, 5/30/71, Mars orbiter 11/13/71 to 10/27/72

Mariner 10, 11/3/73, Venus swingby 2/5/74, Mercury 3/29, 9/21, 3/16/75

Viking 1, 8/20/75, Mars orbiter/lander, orbit 6/19/76, landing 7/20/76

Viking 2, 9/9/75, Mars orbiter/lander, orbit 8/7/76, landing 9/3/76

Voyager 1, 9/5/77, Jupiter 3/5/79, Saturn 11/12/80 with pictures, continuing on interstellar mission

Voyager 2, 8/20/77, Jupiter 7/9/79, Saturn 8/25/81, Uranus 1/24/86, Neptune 8/25/89, continuing on interstellar mission

Seasat, 6/27/78, ocean radar satellite, operated three months

Solar Mesosphere Explorer, 10/6/81, successful

Infrared Astronomical Satellite, 1/25/83, NASA/United Kingdom/Netherlands orbiting infrared telescope, operated to 11/23/83

Magellan, 5/4/89, Venus radar mapper, orbited 8/10/90 - 10/13/94, mapped 99% of planet

Galileo, 10/18/89, Jupiter orbiter/probe; Venus swingby 2/10/90, Earth swingby 12/8/90, asteroid Gaspra flyby 10/29/91, second Earth swingby 12/8/92, Ida flyby 8/28/93, Shoemaker-Levy observations 7/94; arrived at Jupiter 12/7/95 for two year mission and accomplished atmospheric probe portion of mission; extended mission focused on Jupiter's moons Europa and Io; currently in third extension of mission

Ulysses, 10/6/90, European Space Agency/NASA solar polar mission; Jupiter swingby 2/8/92, solar southern polar passage 6/94-11/94, northern passage mid-1995

Mars Observer, 10/25/92, lost at Mars orbit insertion (8/24/93)

Topex/Poseidon, 8/10/92, U.S.-French ocean satellite, operating

Mars Global Surveyor, 11/7/96, entered Martian orbit 9/12/97, science mission began 3/99, operating

Mars Pathfinder, 12/4/96, landed 7/4/97 and deployed isntrumented rover

Cassini, 10/15/97, Saturn orbiter with Huygens descent probe to study Saturn's moon Titan; Venus flybys 4/26/98 and 6/24/99, Earth flyby 8/18/99, Jupiter flyby 12/30/00, Saturn arrival 7/1/04, Huygens descent 1/14/05

Deep Space 1, 10/24/98, tested ion engine and 11 other advanced technologies; asteroid flyby 7/99, comet flyby 9/01

Mars Climate Orbiter, 12/11/98, lost during Mars arrival 9/23/99

Mars Polar Lander and Deep Space 2 microprobes, 1/3/99, lost during Mars arrival 12/3/99

Stardust, 2/7/99, en route to comet flyby 1/2/04, Earth return 1/15/06

Wide-field Infrared Explorer, 3/4/99, telescope coolant lost shortly after launch

Quick Scatterometer (QuikScat), 6/19/99, ocean winds satellite, operating

Active Cavity Irradiance Monitor Satellite (AcrimSat), 12/20/99, Earth-orbiting satellite monitoring Sun’s radiation output, operating

2001 Mars Odyssey, 4/7/01, entered orbit 10/24/01, science mission began 2/02, operating

Genesis, 8/8/01, solar wind sample return, Earth return in 9/04

Jason 1, 12/7/01, U.S.-French ocean satellite, operating

Gravity Recovery and Climate Experiment, 3/17/02, twin satellites mapping Earth’s gravity, operating

Major Instruments on Other Spacecraft

Instrument; Launch Date; Host Spacecraft; Purpose/Comment

Wide Field/Planetary Camera, 4/24/90, NASA’s Hubble Space Telescope, main camera for orbiting telescope

Wide Field and Planetary Camera 2, 12/2/93, NASA’s Hubble Space Telescope, camera that solved telescope’s optical problem

NASA Scatterometer, 8/17/96, Japan’s Advanced Earth Observing Satellite, mapped sea winds through early 1997

Multi-angle Imaging Spectro-Radiometer, 12/18/99, NASA’s Terra satellite, Earth imaging

Advanced Spaceborne Thermal Emission and Reflection Radiometer, 12/18/99, NASA’s Terra satellite, Japan-U.S. land-mapping instrument

JPL Payloads on Space Shuttle Missions

Payload Name; Shuttle Flight; Launch/Landing Dates; Purpose

Shuttle Multispectral Infrared Radiometer; STS-2; November 12-14, 1981; remote identification of rock-forming minerals

Shuttle Imaging Radar-A; STS-2; November 12-14, 1981; imaging radar

Fiber Optic Data Transmission Experiment; STS-41C; April 6-13, 1984; measure long-term radiation effects on communication systems in experiment on Long Duration Exposure Facility deployed on this mission; retrieved on mission STS-32, January 9-20, 1990

Shuttle Imaging Radar-B; STS-41G; October 5-12, 1984; imaging radar

Atmospheric Trace Molecule Spectroscopy Experiment; STS-51B, April 29-May 6, 1985; STS-45, March 24-April, 1992; STS-56, April 8-17, 1993; STS-66, November 3-14, 1994; measurement of trace and minor gases in Earth's atmosphere

Dexterous End Effector Experiment; STS-62; March 4-18, 1994; to test sensor on shuttle robotic arm

Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar; STS-59, April 9-20, 1994; STS-68, September 30-October 11, 1994; imaging radar

Cryo System Experiment; STS-63; February 3-11, 1995; test cryocooler and heat pipe

KidSat; STS-76, March 22-31, 1996; STS-81, January 12-22, 1997; STS-86, September 25-October 6, 1997; sharing Earth images online with schools

Inflatable Antenna Experiment; STS-77; May 19-29, 1996; test antenna structure designed to be inflated in orbit

Confined Helium Experiment; STS-87; November 19-December 5, 1997; high-resolution test of the theory of confined systems

Electronic Nose (E-nose); STS-95; October 29-November 7, 1998; air quality technology inspired by human nose architecture

Shuttle Radar Topography Mission; STS-99; February 11-22, 2000; high-resolution database of Earth topography

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